

Dr. Stephen Macadam.—For the last fourteen years the author has devoted much attention to the illuminating values of different qualities of paraffin oils in various lamps, and to the production of permanent illuminating gas from paraffin oils. The earlier experiments were directed to the employment of paraffin oils as oils, and the results proved the superiority of the paraffin oils over vegetable and animal oils, especially for lighthouse service. The later trials were mainly concerned with the breaking up of the paraffin oils into permanent illuminating gas, and the results formed the basis on which paraffin oil gas has been introduced into the lighthouse service of Great Britain, both for illuminating purposes and as fuel for driving engines of fog-horns. The following table shows the results of his investigations on the relative values of the crude, green, and blue oils:—

	Crude	Green	Blue
Gas per gallon in cubic feet ...	98	102	127
Candle power ...	50	53	54
Light value of gas from ton of oil given in lbs. of sperm candles	4494	4741	6044

On the Assimilation of Atmospheric Nitrogen by Plants, by W. O. Atwater.—It is almost a universal opinion that free nitrogen is not assimilated by plants. He referred to the classic experiments of Boussingault and Lawes, of Gilbert and Pugh, which, commonly regarded as decisive, may have been performed without consideration to certain conditions. Experiments made by the author show that at any rate certain plants grown under normal conditions do assimilate nitrogen. Peas were grown in sand which had been purified by burning and washing, and to which were applied nutritive solutions containing known quantities of nitrogen. The amount of nitrogen supplied to the plant plus the amount contained in the seed was compared after the experiment with the amount given by analysis of the plant and the residual solution. The excess of the latter amount over the former, which in some cases was excessive, represented the nitrogen acquired from the air.

Prof. Gilbert dissented from the conclusion drawn by Prof. Atwater, as he had found that, the greater the care used to prevent foreign matters accumulating on the plants under experiment, the less nitrogen was found in excess of that obtained from the seed and soil.

PROF. FRANKLAND communicated the results of a study of the phenomena attending the discharge of accumulator-cells containing alternate plates of lead peroxide and spongy lead: (1) The energy of a charged storage-cell is delivered in two separate portions, one having an E.M.F. of 2 volts and upwards, the other an E.M.F. of 0.5 volt and under. One of these may be conveniently termed *useful*, and the other *useless*, electricity. (2) The proportion of useful electricity obtainable is greatest when the cell is discharged intermittently, and least when the discharge is continuous. (3) Neither in the intermittent nor continuous discharge at high E.M.F. is the current, through uniform resistance, augmented by rest. At low E.M.F., however, the current, after continuous discharge of the high E.M.F. portion, is greatly augmented, but only for a few minutes. This augmentation of current at low E.M.F. after rest is hardly perceptible when the high E.M.F. discharge has been taken intermittently. (4) The suddenness of fall in potential indicates two entirely distinct chemical changes, the one resulting in an E.M.F. of about 2.5 volts, the other in one of about 0.3 volt. (5) The chemical change producing low electromotive force is the first to occur in charging, and the last to take place in discharging the cell. It is the change which occurs during what is called the "formation" of a cell, and, for economy's sake, a reversal of this change should never be allowed to take place. (6) Currents of enormous strength can be readily obtained from storage batteries coupled up in parallel, viz. a current of 25,000 amperes from only 100 cells. Such a current reduces to insignificance the output of the large dynamo ever built. It is to be hoped that currents of this magnitude will open up new probabilities of research into the constitution of matter.

SECTION C—GEOLOGY

Plan for the Subject-Bibliography of North American Geology, by G. K. Gilbert, of the U.S. Geological Survey.—The United States Geological Survey is engaged on a Bibliography of North American Geology. The work when completed will give the title of each paper with the title-page of the containing

book, and the number of plates, the whole being arranged alphabetically by authors. There is in contemplation also the simultaneous preparation of a number of more restricted bibliographies, each covering a division of geologic literature. The plan includes abbreviated titles of papers with reference to the pages on which the special subjects are treated, the entries in each bibliography being arranged alphabetically by authors. The selection of topics for treatment in this manner involves the classification of geologic science, and Mr. Gilbert submitted a tentative classification requesting the criticism of geologists.

Marginal Kames, by H. Carvill Lewis, A.M., Professor of Geology at Haverford College.—After reviewing the work on American kames, and the theories of the origin of kames, the author describes his investigations of short kames at the extreme margin of the ice-sheet along the line of the terminal moraine in Pennsylvania. These *marginal kames* run *backwards* from the edge of the ice, draining it by a sub-glacial drainage. These kames are discussed in detail, and are thought to represent sub-glacial rivers formed during the melting of the ice-sheet.

On the Geology of South Africa, by T. Rupert Jones, F.R.S., F.G.S., &c.—The contour of the south coast is parallel with the outcrop of the strata in the interior, from Oliphant's River (31° 40' S. lat.) on the west coast, southward to the Cape, and then eastward to about 33° 30' S. lat. Here the edges of the strata, formerly bending round to the north, have been swept away to a great extent; but their outcrop is again seen on the east coast at St. John's River (31° 40' S. lat.), where they strike north-eastwardly through Natal, probably far up the country. (1) Gneissic rock and the Namaqualand Schists apparently underlie the others, coming out on the north-west, and exposing a narrow strip on the south coast. (2) Mica Schists and Slates, interrupted by Granites here and there, form a curved maritime band, from about 30 to 70 miles broad, and are known as the Malmesbury Beds (Dunn). These and the beds next in succession (the Bokkeveld Beds, 3) are overlain unconformably by the Table-Mountain Sandstone (4), 4000 (?) feet thick, which forms patches and extensive ridges, and possibly dips over No. 3, to join No. 5, the Witteberg Beds. Nos. 3 and 5, together about 2100 feet thick, lie parallel, and form a concentric inner band. The former contains Devonian fossils; the latter is probably of Carboniferous Age (with *Lepidodendron*, &c.), and forms the Wittebergen and Zwartbergen in the Cape District, and the Zuurbergen in Eastern Province. The Ecce Beds (6) come next; Lower Series, 800 feet; Conglomerate Beds (Dwyka), 500 feet; Upper Series, 2700 feet; conformable with No. 5; in the south much folded, and in undulations throughout, until it passes under the next set of beds, No. 7, in some places 50 miles to the north. The Ecce Beds have fossil wood and plant remains in abundance here and there, but these have not been clearly determined. This series has not been well defined until lately, and even now its limits are not fully determined. It includes the Karoo Desert, and therefore takes in the lowest members of Bain's great Karoo Formation, Nos. 12 and 14 of his map (1856), or the Ecce, Koonap, and part of the Beaufort Beds of Jones (1867). The series No. 7, horizontal and unconformable on the Ecce Beds at the Camdeboo and elsewhere, retains the name of Karoo Sandstones: and after a width of about 40 miles is conformably surmounted by a set of somewhat similar beds (8) in the Stormberg; and thus No. 7 should be regarded as the Lower, and No. 8 the Upper, Karoo Sandstones. The latter end off northwards in the Draakensberg, Natal, Orange Free State, the Transvaal, and Zululand, with the still horizontal Cave Sandstone and associated beds. The Lower Karoo Sandstones probably thin away northwards beneath the others. Below the Karoo Sandstones, and dying out southwards near the Camdeboo (Prof. Green), are the Shales (7*), which constitute the country around Kimberley, described as the Olive Shales of the Karoo Formation by G. W. Stow. These die out northward against the old rocks of Griqualand-West and the Transvaal. They contain Glacial Conglomerates in their lowest (earliest) beds, in Griqualand-West, just as the Ecce series has its great Glacial Conglomerate (the Dwyka Conglomerate in No. 6) in its lowest portion. As the Stormberg Beds (8) lie upon the Olive or Kimberley Shales (7*) in the Orange Free State, the Lower Karoo Sandstones (7) must die out northwards. The Kimberley Shales contain some Reptilian bones and plant remains, and some coal on the Vaal; the Karoo Sandstones are rich with *Dicynodont* and other Reptilian bones, and have some Fish remains; and their upper portion (Stormberg) contains Ferns and Cycadeous leaves, and some seams of coal. A fossil mammal also has been found in this series. Throughout its range the

Karoo Series is traversed with igneous dykes. Limestones and Sandstones (9) with fossils of nearly pure Jurassic, but with some of Cretaceous type, occur unconformably in the Eastern Province. Their fossil Flora is like that of the Stormberg Beds. Cretaceous strata (10) are known on the Natal coast: and Tertiary and post-Tertiary deposits (11) form several patches on the east, south, and west coasts.

THE SOUTH AFRICAN FORMATIONS

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|--|---|------------------------------|--|---|--------------------------|--------------------------|-----------------------|--------------------|---|------------------------------|--|---|
| 11. Tertiary and Post-Tertiary, 100'? | (Unconformable on several different rocks) | | | | | | | | | | | |
| 10. Cretaceous | (Unconformable on Carboniferous?) | | | | | | | | | | | |
| 9. Jurassic | <table border="0"> <tr> <td>Uitenhage Formation</td> <td> <table border="0"> <tr> <td>Trigonia Beds</td> <td rowspan="4">} 400'?</td> </tr> <tr> <td>Wood-bed</td> </tr> <tr> <td>Saliferous Beds</td> </tr> <tr> <td>Zwartkop Sandstone</td> </tr> </table> </td> </tr> <tr> <td></td> <td>Enon Conglomerate, 300'</td> </tr> <tr> <td></td> <td>(Unconformable on Devonian and other old rocks in Albany)</td> </tr> </table> | Uitenhage Formation | <table border="0"> <tr> <td>Trigonia Beds</td> <td rowspan="4">} 400'?</td> </tr> <tr> <td>Wood-bed</td> </tr> <tr> <td>Saliferous Beds</td> </tr> <tr> <td>Zwartkop Sandstone</td> </tr> </table> | Trigonia Beds | } 400'? | Wood-bed | Saliferous Beds | Zwartkop Sandstone | | Enon Conglomerate, 300' | | (Unconformable on Devonian and other old rocks in Albany) |
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| Triassic | <table border="0"> <tr> <td rowspan="2">Karoo Beds</td> <td>8. Upper</td> <td> <table border="0"> <tr> <td>Cave Sandstone, 150'</td> </tr> <tr> <td>Red Beds, 600'</td> </tr> <tr> <td>Stormberg Beds, 1000'</td> </tr> </table> </td> </tr> <tr> <td>7. Lower</td> <td> <table border="0"> <tr> <td>Sandstones and Shales, 5000'</td> </tr> <tr> <td>7*. Kimberley or Olive Shales and Conglomerates, 2300'</td> </tr> </table> </td> </tr> </table> | Karoo Beds | 8. Upper | <table border="0"> <tr> <td>Cave Sandstone, 150'</td> </tr> <tr> <td>Red Beds, 600'</td> </tr> <tr> <td>Stormberg Beds, 1000'</td> </tr> </table> | Cave Sandstone, 150' | Red Beds, 600' | Stormberg Beds, 1000' | 7. Lower | <table border="0"> <tr> <td>Sandstones and Shales, 5000'</td> </tr> <tr> <td>7*. Kimberley or Olive Shales and Conglomerates, 2300'</td> </tr> </table> | Sandstones and Shales, 5000' | 7*. Kimberley or Olive Shales and Conglomerates, 2300' | |
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| | (Unconformable on Ecca Beds in the south, and on the old Vaal and Kaap series in the north) | | | | | | | | | | | |
| Carboniferous? | <table border="0"> <tr> <td rowspan="3">}</td> <td>6. Ecca Beds</td> <td> <table border="0"> <tr> <td>Upper Ecca Beds, 2700'</td> </tr> <tr> <td>Dwyka Conglomerate, 500'</td> </tr> <tr> <td>Lower Ecca Beds, 800'</td> </tr> </table> </td> </tr> <tr> <td></td> <td>5. Witteberg and Zuurberg Quartzites, 1000'?</td> </tr> <tr> <td></td> <td>4. Table-Mountain Sandstone, 4000'</td> </tr> </table> | } | 6. Ecca Beds | <table border="0"> <tr> <td>Upper Ecca Beds, 2700'</td> </tr> <tr> <td>Dwyka Conglomerate, 500'</td> </tr> <tr> <td>Lower Ecca Beds, 800'</td> </tr> </table> | Upper Ecca Beds, 2700' | Dwyka Conglomerate, 500' | Lower Ecca Beds, 800' | | 5. Witteberg and Zuurberg Quartzites, 1000'? | | 4. Table-Mountain Sandstone, 4000' | |
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| | (Unconformable on the Old Cape Schists and Slates and on the Bokkeveld Beds) | | | | | | | | | | | |
| Devonian | 3. Bokkeveld Beds, 1100' | | | | | | | | | | | |
| | (Probably unconformable to the Malmesbury Beds) | | | | | | | | | | | |
| Silurian? | 2. Malmesbury Beds, Mica Schists and Slates of the Cape | | | | | | | | | | | |
| | (Probable unconformity) | | | | | | | | | | | |
| | 1. Namaqualand Schists and Gneiss | | | | | | | | | | | |

SECTION G—MECHANICAL SCIENCE

On the Flow of Water through Turbines, by Arthur Riggs, President of the Society of Engineers, London.—After remarking that a strict adherence to the older accepted rules of design never produces thoroughly efficient turbines, and that in the best of such motors these rules are disobeyed, the writer pointed out how little reliable practical information can be obtained from all the voluminous literature relating to turbines. He also stated that the course of a stream flowing through the guides and buckets of a turbine had no appreciable influence upon the duty obtained, so long as one essential condition was observed—namely, that its velocity should be gradually reduced to the least that will carry it clear of the buckets. In comparing screw propellers and turbines, each were shown to possess similarities; and experiments made by the writer, and published in the *Transactions of the Society of Engineers for 1868*, were referred to as explanatory of this view of the case. It was further pointed out that there is no such thing as absolute motion, for all velocities are relative to something else; and thus in a turbine we need only concern ourselves with such diminution in velocity as occurs in relation to the earth, and not necessarily with velocities in relation to the moving buckets of a turbine. Impact was considered as a pressure due to the destruction of velocity in a direction perpendicular to a plane surface, while reaction, from a vertical stream, is the natural integration of the horizontal elements of the successive pressures which act vertically in regard to the concave surface upon which the stream is caused to flow. In most theoretical investigations it is assumed that impact and reaction are equal when a current is divided at right angles to its

original course, and this condition implies that a maximum result should be obtained from screw propellers when their blades stand at 45° to the plane of rotation. But in practice an angle of 42° is found best, and this is so because impact and reaction under the conditions stated are not equal, but bear to each other the proportions of 71 to 62; and these proportions give an inclination of screw-blade of 41° by taking an experiment which corresponds most closely with the conditions of a screw propeller. The resultant due to these proportions is found to be 94.25 units, whereas if impact had been the same as reaction it would have been 100.75 units, and this is the total amount that can be aimed for in designing a screw propeller, or pure impact turbine, where the stream is merely turned through a right angle from its original course. But if instead of turning the current only 90° it is turned through 180° , then impact and a still further reduced reaction both act vertically downwards; and it is their sum, and not merely their resultant, that constitutes the total pressure obtainable from a jet of water. Taking the standard unit employed in the experiments described, this sum is found to be 126, of which 71 represents impact, and the remaining 55 the effect of a complete reaction. Therefore, in designing a turbine or screw propeller, it would seem desirable to aim at changing the direction of a stream, so far as possible, into one at 180° to its original course, for it may be said that carrying out this view has placed the modern scientifically designed turbine in that pre-eminent position it now holds among all hydraulic motors.

The Severn Tunnel Railway, by T. Clarke Hawkshaw.—This paper described the Severn Tunnel Railway works, begun in 1873, and now approaching completion. The railway is being made to shorten the direct railway route between the South of England and South Wales. It passes under the River Severn about half a mile below the present steam ferry, which connects the South Wales and Bristol and New Passage lines. The river, or estuary, is about $2\frac{1}{4}$ miles wide. The length of the line is $7\frac{1}{2}$ miles, of which $4\frac{1}{2}$ miles are in the tunnel which passes under the Severn. The bed of the river is formed principally of Trias rocks (marls, sandstones, and conglomerates), in nearly horizontal strata. These overlie highly inclined Coal-measure shales and sandstones, which are also exposed in the river bed. The tunnel is made almost wholly in rocks of the Trias and Coal-measure formation, the exception being a little gravel passed through near the English end. The lowest part of the line is below the shoots, the deepest part of the river, where there is a depth of 60 feet of water at the time of low water, and 100 feet at the time of high water. Below the shoots, the line is level for 13 chains, rising 1 in 100 to the English end, and 1 in 90 to the Welsh end. Below the shoots, there is a thickness of 45 feet of rock (Pennant sandstone) over the brickwork of the tunnel. Under the Salmon Pool there is less cover, only 30 feet of Trias marl. Much water has been met with throughout the works, which have been flooded on several occasions. In 1879 the works under the Severn were drowned for some months by the eruption of a large land spring into one of the driftways under land on the Welsh side of the river. On another occasion a cavity was formed from the driftway under the Salmon Pool to the bed of the river, when a hole, 16 feet by 10 feet, was found in the marl. The works were flooded by the water which found an entry through this hole. It was filled with clay, and the tunnel is now finished beneath it. The quantity of water now being pumped is about 19,000 gallons per minute. Additional pumps have been erected, as the large land spring, which has been penned back by a brick wall, still remains to be dealt with. When all the pumps are available, the total power will be equal to 41,000 gallons a minute. The tunnel is for a double line of way, and will be lined throughout with vitrified bricks set in Portland cement mortar. It is being made by the Great Western Railway Company. Sir John Hawkshaw is engineer-in-chief; Mr. C. Richardson, engineer; and Mr. T. A. Walker, the contractor.

SECTION H—ANTHROPOLOGY

THE first paper read in this Section was that of Prof. Boyd Dawkins, *On the Range of the Eskimo in Time and Space*. In his introductory sentences Prof. Dawkins remarked on the importance and interest of his subject. He began his inquiry into the condition of the Eskimo by particularising those of Greenland. By the aid of a sketch-map upon the blackboard, he traced the progress of the dwellers on the Arctic shores, following them to the continent of Asia. He noted that in the